



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

T H E

AMERICAN NATURALIST.

Vol. III.—FEBRUARY, 1870.—No. 12.



SKATES' EGGS AND YOUNG.

BY F. W. PUTNAM.



It is an interesting fact that while the class of bony, or *true* Fishes, both fresh water and marine, are, with very few exceptions, oviparous, and lay immense numbers of eggs, the *Selachians*, or sharks and skates and their allies, are, with equally few exceptions, viviparous, and bring forth but few young at a time. One of the exceptions to the rule of viviparity among the *Selachians* is the genus *Raja*, to which our common species of skates and rays belong. Though the fact that skates lay eggs has been known for centuries, still to this day there is probably no class of objects picked up by the wanderer on the sea beach that excites curiosity so much as the egg cases of the several species of skates, after he has found out what they are. On being seen for the first time, and before close examination, I venture to state that the majority of persons regard them as some vegetable production, and pass them by as the supposed "bladder" of the seaweed with which they are often so closely connected by their tendrils as to have the appearance of being part of the plant, which they also greatly resemble in color and general appearance.

Some sharp eyed fisherman long ago, ascertaining that the

queer shaped things which he found on the beach were in fact little pockets, or sacks opened at one end, not knowing what else they could be, concluded that in some way they must be connected with the "maids of the ocean;" and what more natural than to suppose them to be the purses to hold the pearls and other valuables of the mysterious maids? and what better name than "Mermaid purses" could be desired? From this first christening, and following the common rule adopted for such cases—that of keeping as far away as possible from the real nature of the object—they have been called, and are generally known as "sea purses" and "sailor's purses." The only popular name bearing on their real origin is that given to them on some portions of the English coast, where they are called "skate barrows," from their resemblance in form to a hand-barrow, and the knowledge of the christener that they were produced by the skates.

As common as these egg cases are on our beaches, it is very seldom, and only at certain seasons, that they are found containing the egg or embryo. When fresh and filled by the embryo they are plump and swollen and of a much lighter olive color than when empty, dry and shrivelled. As long as the embryo is in the case no opening to the pouch can be detected, until just at the time when the young skate is to make his way into the world and commence his struggle for existence, consisting principally in keeping himself from going into the ever ready mouths of his own kin of fin, to whom he forms a tempting morsel. Just as incubation comes to a close, then, the substance at one end of the case softens and the upper and under layers are pushed apart by the young skate who "noses" his way out; the two layers then spring back into place and the case on drying shows no sign of an opening, unless it is again softened and the layers carefully separated.

We do not yet know the breeding season of our species, but Pennant in his "British Zoölogy," states that the "skates generate in March and April, at which time they swim near

the surface of the water, several of the males pursuing one female; and adhere so fast during coition, that the fishermen frequently draw up both together, though only one has taken the bait. The females begin to cast their *purses* in May, and continue doing so till September. In October they are exceedingly poor and thin, but in November they begin to improve, and grow gradually better till May, when they are in the highest perfection. The males go sooner out of season than the females."

We extend this quotation from Pennant to take in that part of the paragraph relating to the *condition* of the fish purposely, in order to call attention to the great waste of food on our New England coast. Here, to tell a person that a skate is good eating is about the same as to tell him that the horse is good eating. His reply will be, "you may eat it if you wish but I would rather have something else," and yet the skate and the horse are good wholesome food, which we should probably enjoy after we got used to it. In many parts of Great Britain and France, to say nothing of China, skates of a tender age, *i.e.*, about half grown, when they are called "maids," and also many sharks are considered good and wholesome food, and are regularly sold in the markets. Our Celestial friends on the Pacific coast have brought skates and sharks into demand in that region, and in time we shall have the benefit of their custom here, when skates and sharks will be caught for other purposes than the making of "pure Cod liver oil;" but until the Celestial element predominates over the Celtic, salt-cod and herrings will hold sway over the poor Selachians now condemned to die for their *livers* sake alone.

Another clause in the quotation from Pennant leads us to say a word or two, before turning again to our skates' eggs.

The male skates and sharks have appendages to the ventral fins which have been called claspers, from their supposed use in the act of coition. These appendages are in reality the intromittent organs of the male, and what were called

the legs of the monster shark exhibited about the country during the last two seasons, and familiar to every one from the newspaper descriptions and figures as "the great unknown animal, half fish, half quadruped," captured off Eastport, were simply these organs.

The skates and rays and the genus *Scyllium*, or spotted sharks, and their near allies, all lay eggs, contained in and protected by the singular horny cases, or shells. These cases are of various sizes and shapes according to the species of skate or shark by which they are laid. Their general form is that of the skates' figured in this article, but others are much larger, and those of the sharks are longer and narrower than the skates. On the coast of California a very large case is often found which always contains more than one egg, generally three. I remember one, received at the Museum of Comparative Zoölogy about twelve years since, that was several inches in length and contained three nearly developed embryos.

All these egg cases are provided with a more or less developed horn at each of the four corners. These horns are hollow, and are in fact tubes for the passage of water to the inside of the case and its exit at the other extremity of the sack. By this means the egg and tender embryo while protected by the horny covering or case, is furnished with a constant supply of water during its development. On the side of the case are numerous tendrils or filaments, by which the case is firmly fastened to seaweed, and hence it is that it is only after a violent storm that fresh cases are to be found on our beaches.

A few interesting questions which have not yet been fully solved, are: How do the cases become attached to the seaweed? Are the tendrils fastened by the mother skate in any way, or are they, when soft and fresh, so arranged that they naturally twine around the seaweed as soon as they come in contact with it? Does the skate when about to deposit her eggs go to a spot where seaweed is abundant, or

does she cast them at random and trust to the cases drifting to some suitable place for attachment?

That the mother when about to deposit her eggs selects a proper place for their attachment, just as other species go to regular spawning grounds, is, I think, proved by Mr. Thompson in his "Natural History of Ireland," who even asks the question if it is not probable that, like certain species of birds, the same fish (in this instance one of the spotted sharks) may return time after time to the same spot to deposit her eggs. This query arose from the fact that there were sent to him in December, 1843, two plants of the tangle (*Laminaria digitata*) dredged together from a depth of between two and three fathoms, to one of which was attached fourteen of the large ova and to the other twelve. "Of the fourteen six were very old [and empty], six of middle age [and empty], and two quite fresh [*i. e.*, with undeveloped eggs]. Of the twelve on the other plant, four were very old, four of middle age, and four were fresh." Now if this does not prove that all these eggs were deposited at three different seasons by the same fish—which, with Mr. Thompson, I believe is probable—it certainly proves that the fishes seek a proper place for the attachment of their eggs and do not leave them to the mercy of tide and wave.

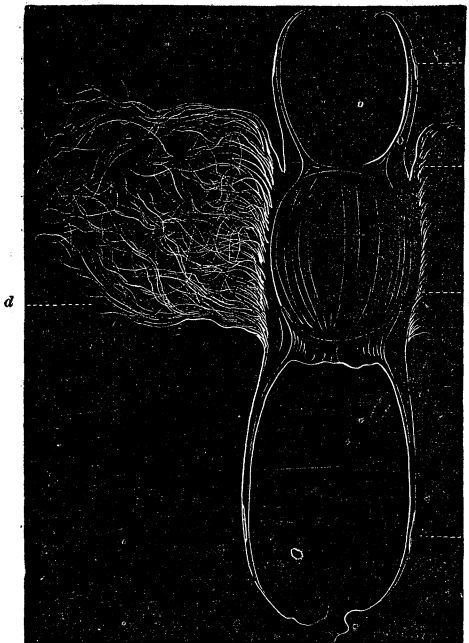
In January, 1864, Professor Jeffries Wyman communicated the results of his "Observations on the Development of *Raia batís*" to the American Academy of Science and Arts, and the article is printed in the Memoirs of the Academy for that year. These "Observations" contain all that is known relating to the development of the common skate of our coast, and should be read by every one interested in the subject.

Professor Wyman has granted me the use of the woodcuts illustrating his article, and rather than rewrite, abstract, and otherwise pilfer from his paper, I shall, with this acknowledgment, make extended quotations from his Memoir, and

add the explanations to the figures which he has so kindly placed at my disposal for this article.

"Egg case.—This singular structure has the general form of such parts in egg-laying Selachians. The whole case, in the species here described is between six and seven inches in length, of a deep greenish-brown color, and composed of minute parallel filaments, which give it a striated appearance and a silky lustre. The central pouch (fig. 85, *a*), for the protection of the yolk and the embryo, is about two inches long, an inch and a half wide, bulges in the middle, and has a hollow, slender, curved horn

Fig. 85.



Egg case of Skate, one-half natural size; *a*, pouch for the yolk; *b* *b'*, openings for the inward and outward flow of water; *c*, spur; *d*, membrane formed by the interweaving of the lateral filaments.

projecting from each corner. The fore end of the pouch is deeply concave, and thickest, while the hinder is thin, nearly square, and ragged; it is from this part that the embryo escapes, after the separation of the upper and under walls from each other. The hinder horns project backwards as they lie in the oviduct, and are of about twice the length of those at the other end. The outer edge of each horn is the more rounded, and near the free end has an oblong slit (*b* *b'*) for the inward and outward flow of the water which passes through the egg during incubation.

At the base of each fore horn is a slender fore projection or spur (*c*), about half an inch in length, the whole outer

border of which breaks up into a series of silky filaments, and these are especially abundant near the free end. Similar filaments are given off from the whole border of the capsule, and all become tangled and woven together in such a manner as to form a broad and somewhat thick membrane on each side (*d*). This membrane was found entire only on cases taken from the oviduct, and on those newly laid. In all such, however, as have embryos somewhat advanced, it is more or less destroyed, and for the most part only tufts of it remain at the base of each horn. The

object of it is not apparent, unless it be to assist in securing an anchorage, by the entanglement of its filaments with submarine plants or rough surfaces.

In a single instance, in the dissection of skates, an imperfect egg-case was found in each oviduct, the development of it having just begun. The hinder horns and the hinder edge of the capsule were the only parts completed. They were contained in the glandular portion of the oviduct, which is quite thick during the reproductive season, and is mostly made up of very minute and slender follicles, of great length. From some of them fibrils protruded, identical in structure with those out of which the cases are made, and which, after being liberated, are doubtless moulded into the shape of these cases, and cemented together by some secretion from the oviduct. The horns are formed in grooves on either side of the duct, and the pouch for the yolk in the intervening space. A careful examination of the ovary and oviduct in the above instance showed the singular fact, that, although some of the yolks were mature, none had as yet been detached from the ovisacs. This circumstance renders it probable, that, after the horny pouch is partially formed, the yolk descends and enters it, and that then the other portions are completed. If this supposition, based upon a single observed instance, were to be confirmed by further examinations, it would prove the existence of an interesting deviation from a rule among animals generally supposed to be without exception, viz.: that the presence of the yolk in the oviduct is necessary before the formation of the egg-coverings can begin.

In none of the cases which we have examined have we found the fetus surrounded either by a membrane or by albuminous matter, but in every instance the yolk and the embryo were fully exposed to contact with the water, which entered by the openings already described. An albuminous covering may have existed at an earlier period, and have been absorbed."

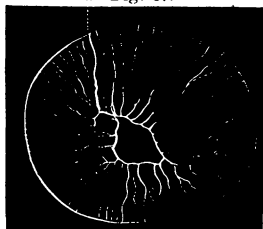
"*Yolk*.—After the body of the embryo has become well defined. it is attached to the yolk by a slender umbilical cord about half an inch in length (fig. 86). The yolk has not the pyriform shape so common in other

Fig. 86. c



Eel-shaped embryo of Skate, connected with the yolk by a slender umbilical cord; *a*, omphalo-mesenteric artery; *c*, dorsal fins; *d*, anal fin.

a Fig. 87.



Under side of the yolk of fig. 86, showing the continuation of the artery, *a*, and the connecting with the triangular terminal sinus.

Selachians, but is nearly spherical, though somewhat flattened above and below. The cord has the length just mentioned only temporarily, and soon begins to shorten, and contracts until the fœtus rests once more upon the surface of the yelk (figs. 91 and 93). The two omphalo-mesenteric vessels, common to all vertebrates, carry the blood from the embryo to the yelk and back. The artery, a branch of the mesenteric (figs 86 and 93, *a*), passes out beneath the head, over the front of the yelk, and descends to the under surface, giving off minute twigs to the right and left; but the trunk itself does not branch. Dr. John Davy, in his observations on the development of the torpedo, although he figures a vein surrounding the vascular area in the younger specimens, yet makes no reference to it in the text. Agassiz has observed a similar vessel in the yelk of a dog-fish, and has for the first time pointed out its resemblance to the *sinus terminalis* of birds. Dr. Davy's figures, taken in connection with those

Fig. 88.



Embryo of Skate, more advanced than fig. 86, a ventral view, showing the pectoral fins, *a*; the ventral fins, *b*; and the temporary anal fin, *d*.

here given, form a complete series. In the youngest of the specimens described by him the sinus is found on the upper surface of the yelk, and quite near the embryo; in the second, it has receded towards the sides, and the vascular area enlarged to a corresponding degree. In our specimens it is found on the under surface, is of a triangular form (fig. 87), and encloses only a small area. Eventually it contracts still further, and at last wholly disappears, and thus the entire surface of the yelk becomes vascular (figs. 91 and 93).

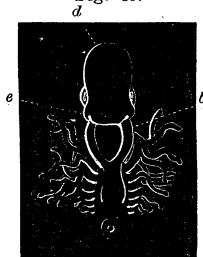
As development advances the yelk is gradually withdrawn into the cavity of the abdomen, as in birds; but the retraction does not appear to be quite complete in the skates until a short time after hatching. In one instance a fully formed skate taken from the egg-case had the yelk reduced to a small flattened mass about two lines in diameter. Very nearly the same condition existed in another, which was already hatched. In a third instance, where the young had been hatched for a longer

time, the yelk had been wholly introduced into the cavity of the abdomen; but a considerable mass of it, still within the abdominal cavity, remained to be absorbed (fig. 96, *a*), where, as in the newly hatched chick, it serves as a reservoir of nourishment. Dr. Davy states that, in the torpedo, the young fish is nourished by the yelk for six weeks after birth. In all cases we have found the vitelline duct entering the intestine just above the spiral valve."

"*Form of the Fœtus.*—The general form of the youngest specimen is long, slender, and gradually tapers to a point backward, as in fig. 86, and may be described in one word as eel-shaped. The head presents two rounded projections, one of them forward (figs. 89 and 90, *d*), forming the

foremost part of the embryo; this is made by the protrusion of the optic lobes, and closely resembles the same part in the embryos of birds; the second (fig. 90, *e*) is directed downward, and contains the cerebral and

Fig. 89.



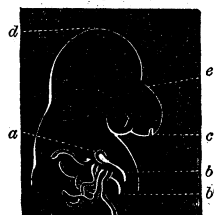
Head of fig. 88, enlarged, showing the first branchial arch *b*, without fringes; the mouth in open space between the first branchial arches; *d*, projection of the optic lobes; *e*, projection of the cerebral lobes.

olfactory lobes behind which are the eyes. These last, which in the earlier stages, as in figs. 86, 88, 92, are on the same level with the surrounding parts, soon become remarkably prominent, as in fig. 94, where they remind us of the eyes of the young of *Malleus*.* In the fully formed fish they are again reduced to nearly the same level with the adjoining integuments. As development advances, the optic lobes cease to form the most prominent part of the head, in consequence of a change of position of the cerebral hemispheres, which rise to the same level with the organs just mentioned, as the facial disk (figs. 93, 95, 92, *b*) advances beneath them. In fig. 91 the embryo has many of the features of a shark; and in fig. 94, with the expansion of the pectoral and ventral fins, it begins to take on the form of the skate."

"*Fins*.—In the youngest specimen examined (fig. 86), a vertical fold of skin stretches along the middle line, from near the head almost to the end of the tail above, and from near the umbilical cord to the same point below. These folds do not pass beyond or become connected around the end of the tail. The dorsals (figs. 86 and 93, *c*) are formed by two vertical extensions of the upper fold, and in this early stage of their existence are placed midway between the base of the tail and its tip, which last tapers to a slender point. The anals (figs. 86, 93, and 95, *d*) are formed from a similar extension of the under fold, and are situated somewhat further forward than are the dorsals. The first (fig. 91, *d*) grows very rapidly, and soon acquires a disproportionately large size; but the second (fig. 91, *d'*) is quite diminutive. Both upper and lower folds and fins have their edges bordered with follicles.

Both dorsal and anal fins undergo a very remarkable change as development advances. The first in the adult are found quite at the end of the tail, instead of the middle, as in the early stage. This change of relative position seems to be effected in part by the more rapid growth of that portion of the tail which is in front of them, while that which is behind scarcely increases in size, and thus

Fig. 90.



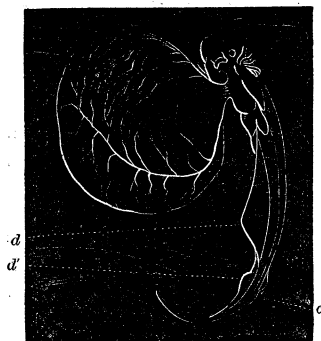
Side view of fig. 89, *a*, first branchial fissure, largest at its outer end, which portion corresponds with the future spiracle; *b*, the inner end; the first arch is in front of this fissure; *b'*, the second fissure, in front of which is the second arch, bearing a fringe; *c*, nasal fossa; *d*, projection of the optic lobes; *e*, cerebral lobes.

* Hammer-headed shark.

the fins are soon nearer the end than the middle. At the time of hatching, the terminal portion is still present (fig. 96, c); but subsequently it is either absorbed, or, what is not improbable, is covered by the extension of the dorsals backward.

The anal fins, the first of which, as already stated, attains to a remarkably large size, are gradually absorbed, and are wholly removed before

Fig. 91.



Embryo of Skate at the Shark-shaped stage. c, the dorsal fins; d, d', the anal fins.

the end of gestation. From the fact of these fins having a temporary existence in the skate, and a permanent one in many sharks, it is not improbable that they may be present in the embryos of all Plagiostomes.

This development, temporary existence, and early removal of the anal fins, gives us another interesting example of the formation of parts which have no obvious use in the economy, and which must be regarded as having merely a morphological value. It falls into the same category with the caudal fin of the embryo of *Pipa*,* which is never used, the teeth of certain Cetaceans, the inferior incisors of the female Mastodon,

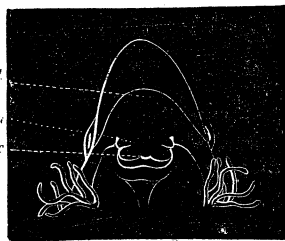
which are all removed without being used, and the milk incisors of the Guinea-pig, which are shed *in utero*.

There is still another point of interest in the morphology of the tail of the species we are here considering; for although symmetrical, it does not at any period assume the heterocercal form, but retains permanently its primary embryonic or protocercal condition.

In this respect the skates hold a lower position than the sharks, nearly all of whom pass through the protocercal into the heterocercal stage.

The pectoral and ventral fins begin as slight ridges on either side, but each soon takes on the form of a half oval disk (fig. 88, a, b). At first the two are nearly continuous in the same plane (fig. 88), but the pectorals (figs. 94 and 95, a) grow the most rapidly, gradually assume a somewhat oblique position, and in a short time partially cover the ventrals. None of the specimens were of a proper age to show whether or not the pectorals were formed first, as is the case with the fore limbs of all the vertebrates whose de-

Fig. 92.



Head of fig. 91, enlarged. a, nasal lobe; b, facial disk; c, upper lip.

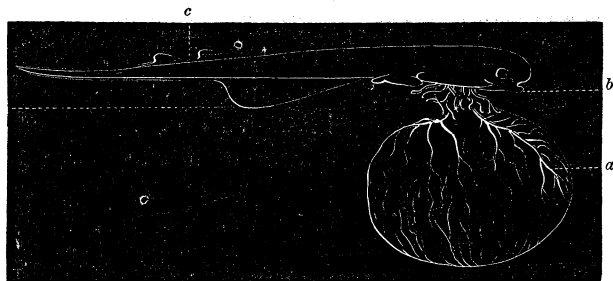
*The singular Surinam Toad whose eggs are developed in cells formed on the back of the parent. — F. W. P.

velopment has been thus far studied. As they grow, they advance on either side of the head in the form of horns (figs. 94 and 95, *a'*), but by degrees the space between these horns and the side of the head is filled up, and thus the eyes and the persistent portion of the first branchial fissure are pushed to the upper surface, and eventually the pectorals gain the foremost part of the side of the head, at the same time becoming united with the extended facial disks.

The tail, as the whole animal increases in size, becomes relatively very much shorter. In the earlier stages the body is only three sixteenths of the entire length of the embryo, but subsequently it is about one half that length, as will be seen by a comparison of figs. 93, 94, 95, and 96."

"*Branchial Fissures and Gills.*—In nearly all adult Selachians there are five gill-openings in each side; Hexanchus and Heptanchus have respectively six and seven such openings. In addition to these, all of the skates and some of the sharks have a peculiar opening just behind the eyes, or

Fig. 93.



More advanced embryo of Skate, having passed through the Eel and Shark-shaped stages and commencing to assume the characteristic form of the adult. *a*, artery; *b*, facial disk; *c*, dorsal fins; *d*, anal fin.

at some point between these and the first branchial fissure, which makes a direct communication, for the most part of a large size, between the top of the head and the pharynx, and to which the terms 'spiracle,' 'event,' 'Spritz-locher,' 'foramina temporalia,' etc., have been applied.

In the youngest embryos of skates here described, we have found the number of gill-openings or branchial fissures seven on each side, all well defined except the last, which is the smallest of the series (figs. 88 and 89). These are all in the same range from before backward, and at this stage the spiracle, as such, is not distinguished from the others. It is characteristic of the early embryos of all Selachians, to have developed, in connection with branchial apparatus, temporary gills which are seen in the form of long and slender filaments projecting from the sides of the neck. They are generally described as coming out through the gill-openings, and as prolongations of the internal gills. Cornalia, who has made a special study of these organs, so describes and figures them. We believe that, in consequence of not having seen embryos sufficiently young, he has been led into an error.

We have found them when first formed, growing from the outer edge of the branchial arch (figs. 89 and 90), and at that time in no way connected with the branchial fissures. In the skate, the first and seventh arch had no fringes at any period, and of the five which had them, the fringes of the foremost ones were the longest, the hindmost being merely short, conical projections. As development advances, the bases of the fringes are gradually covered up, as it seems, by the growth of the portion of each arch in front of them, which is thus projected outward as the body becomes thicker from side to side; the line of attachment of the

Fig. 94.



Fig. 95.



Dorsal and ventral views of fig. 93. *a, a'*, pectoral fins; *b*, facial disk; *c*, ventral fins; *d*, anal fin; *d'*, dorsal fins; *e*, gill fringes.

fringe, which retains its original position, being thus buried between two adjoining arches.

From the fact that the temporary gills are formed before the permanent ones, and from the outer surface of the arch, it is obvious that they cannot be—as commonly described—prolongations of these last-mentioned breathing organs.

The fringes do not cover the whole border of the arch, but are confined to its central portion, and consist of from six to eight filaments each.

We have made no observations on the formation of the internal gills, and cannot therefore explain the connection which eventually exists between these and the fringes, and which at a later period correspond exactly with the descriptions usually given.

The existence of temporary branchial fringes, and their subsequent absorption, is one of the most remarkable characteristics of Selachians, and one in which they differ from all osseous fishes, unless it be the Lepidosiren. All vertebrates, as embryos, agree in this, that they are in their early stages provided with “branchial fissures” and “arches” or, as they sometimes have been called ‘visceral’ arches. Gills or gill fringes, either as temporary or permanent structures, are never formed in any scaly reptile, bird, or mammal. Much confusion and misapprehension have arisen from the constant reiteration of the opinion put forth in the early days of embryology, that all vertebrates at one time have a branchial respiration, an error which is repeated by naturalists even at the present day. Among Batrachians some genera, as *Menobanchus*, *Siren*, etc., have external

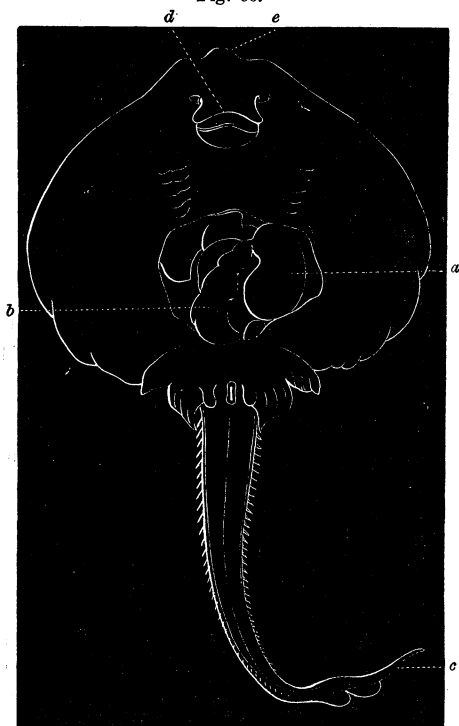
fringes permanently attached to their branchial arches, which are not known to be replaced by, or to coexist with, internal gills. They are their sole organs of respiration, for their lungs are too imperfect and rudimentary to have much physiological importance. In frogs, toads, and salamanders, the external gills are replaced by internal ones, and these in turn by lungs. Thus it will be seen that no Batrachian is permanently provided with internal gills.

Selachians and Batrachians agree in this, that their embryos have in their first stages external fringes growing from the outer surface of the gill arches, and these fringes have the same structure in both. The Selachians still further agree with frogs, toads, and salamanders, in the fact that the outer fringes are absorbed, and are replaced by internal gills. They differ from them, however, in the following particular. Selachians retain their internal gills permanently through life, while, if such exist at all in the Batrachians just mentioned, it is only during the larval stage, and they are soon replaced by lungs. Selachians may therefore be said to pass through stages analogous

to the first and second stages of Anurous Batrachians and salamanders.

The other changes which the fissures pass through before the skate acquires its permanent form are as follows. The seventh fissure is closed up at a very early period, about the time that the dorsals are beginning to be formed. While the first arch bends and is drawn forward as already described in connection with the formation of the jaws, it at the same time becomes broader, so as to widen the distance between the mouth and the first fissure, or the second, after the first is partially closed.

Fig. 96.



Newly-hatched Skate; *a*, yolk-sack in the cavity of the abdomen, connecting with the intestine; *b*; *c*, embryonic portion of the tail which disappears in the adult, and corresponds with the portion of the tail behind the dorsal fins in the figures representing still younger stages; *d*, upper lip; *e*, developed facial disk.

The inner part of the first closes up, while the outer remains open (fig. 90, *a*), is somewhat enlarged, and retains its relative position to the eye. It is very soon widely separated from the other fissures by the rapid growth of the intervening parts, and still further by the extension of the pectoral fins forward between this remnant of the first fissure and those behind it, the former being thus thrown to the upper, and the latter to the under surface. The unclosed portion of the first branchial fissure is thus converted into the spiracle.

The transformation thus described is of very great interest when compared with the changes which occur in the corresponding fissures of the air-breathing vertebrates, and enables us to establish an unexpected homology. Reichert, in his most important investigations of the development of the gill arches ('visceral Bogen') of the pig, has shown that in this animal the first fissure is gradually separated from the others by the widening of the second arch, and for a time, even after all the others are closed up, forms a direct opening from the side of the neck into the pharynx. Afterwards it is divided into an outer and inner portion by a membranous septum; the former being the external auditory canal and the latter the Eustachian tube and the cavity of the tympanum. It will thus be seen that the spiracle is not only a true branchial fissure in the first place, but that in the end it is homologous with the Eustachian tube and the outer auditory passage before these are separated from each other by the membrane of the tympanum.

Professor Huxley, in a series of lectures on the Vertebrate Skeleton, in which the homologies and development of it are discussed with great ability, sets forth a somewhat different view with regard to the formation of the external ear, and maintains that the first step is similar to that in the case of the eyes and nose, viz.: an "involution" or a "pushing in" of the integument. Professor Huxley's observations were made on the chick, and he arrives at the same conclusions as Remak, leaving us to infer that the auditory passage and Eustachian tube have no connection with the branchial fissures. We have gone over the same ground in the pig, and have found Reichert's observations, as mentioned above, fully confirmed.

The relation of the spiracle to the branchial fissures is still further shown by the fact that in some species, as in *Scyllium* and *Læmargus*, it, like the others, is provided with respiratory fringes. In the skate this is not the case, but in the adult a comb-like fold, resembling, and probably having the functions of, a gill, is found just within the spiracular opening."

For a description of the development of the mouth and nostrils, and some other details which have been omitted in these extended quotations, the reader is referred to Professor Wyman's Memoir.